

Fabrication of the HIAD Large-Scale Demonstration Assembly

Hypersonic Inflatable Aerodynamic Decelerator (HIAD)

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IPPW 14, June 12-16, 2017



Introduction

In the last year, many significant development and fabrication efforts have been accomplished, culminating in the construction of a large-scale inflatable structure demonstration assembly. This assembly incorporated the inner three tori of a 12m Mars Human-Scale Pathfinder HIAD conceptual design. The tori were constructed with the current state of the art material set. Numerous design trades and torus fabrication demonstrations preceded this effort. In 2016, three large-scale tori (0.61m cross-section) and six subscale tori (0.25m cross-section) were manufactured to demonstrate fabrication techniques using the newest candidate material sets. These tori were tested to evaluate durability and load capacity. This work led to the selection of the inflatable structure's third generation (Gen-3) structural liner. In late 2016, the three tori required for the large-scale demonstration assembly were fabricated, and then integrated in early 2017. In case future opportunities arise the design includes provisions to add the remaining four tori necessary to complete the full 12m Human-Scale Pathfinder HIAD assembly.

Upcoming Large-Scale Opportunities

- **United Launch Alliance Vulcan SMART (~12m HIAD)**
- **ISS Downmass (~10m HIAD)**
- **Human Mars Pathfinder (~12m HIAD)**

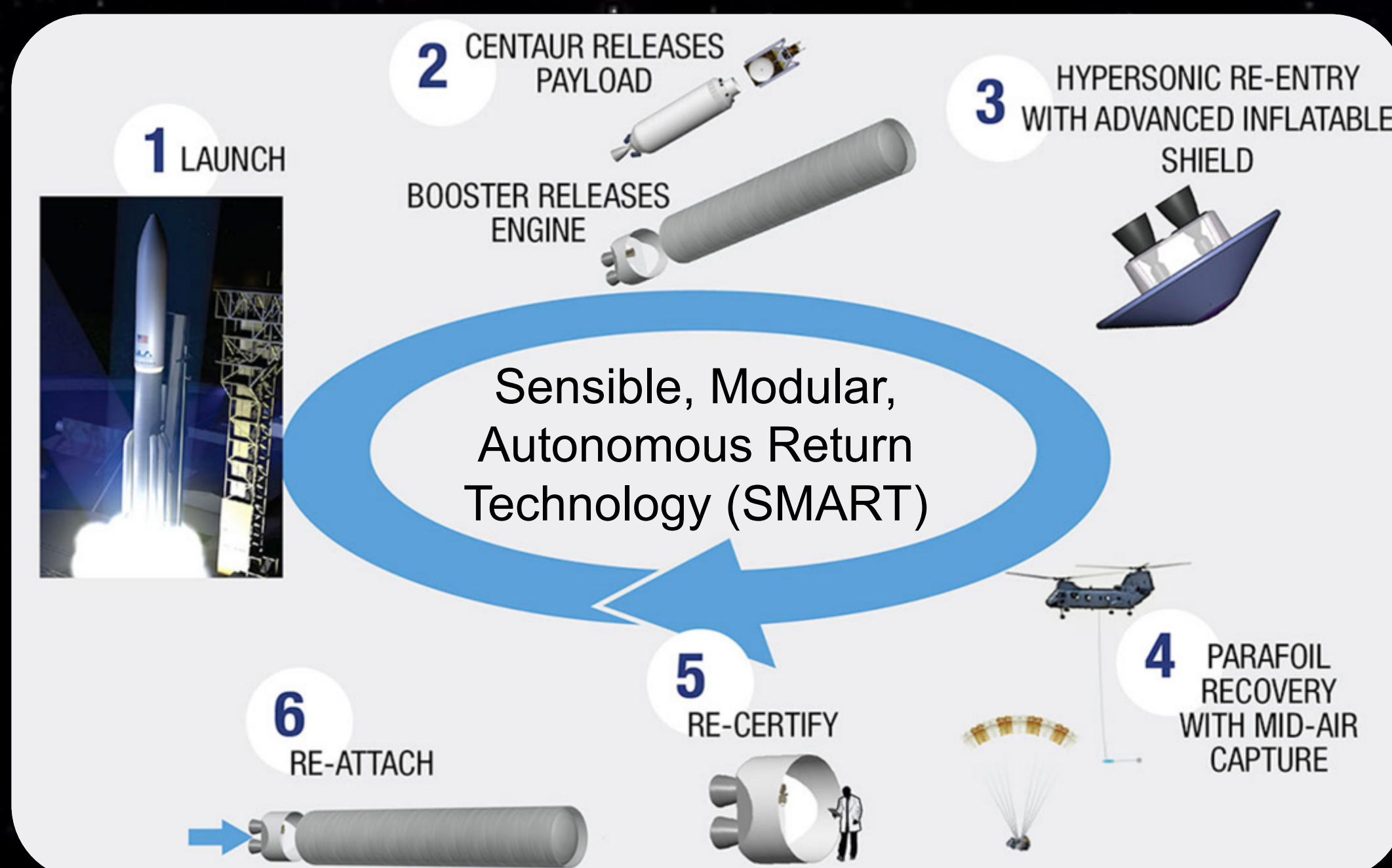


Image Credit: United Launch Alliance

Torus Design and Fabrication

- **New 0.61m (24in) Torus Braid Designed and Fabricated**
- **New Gen-3 Structural Liner**
- **New Fabrication Techniques**



New Torus Braid



Large Scale Torus Initial Inflation

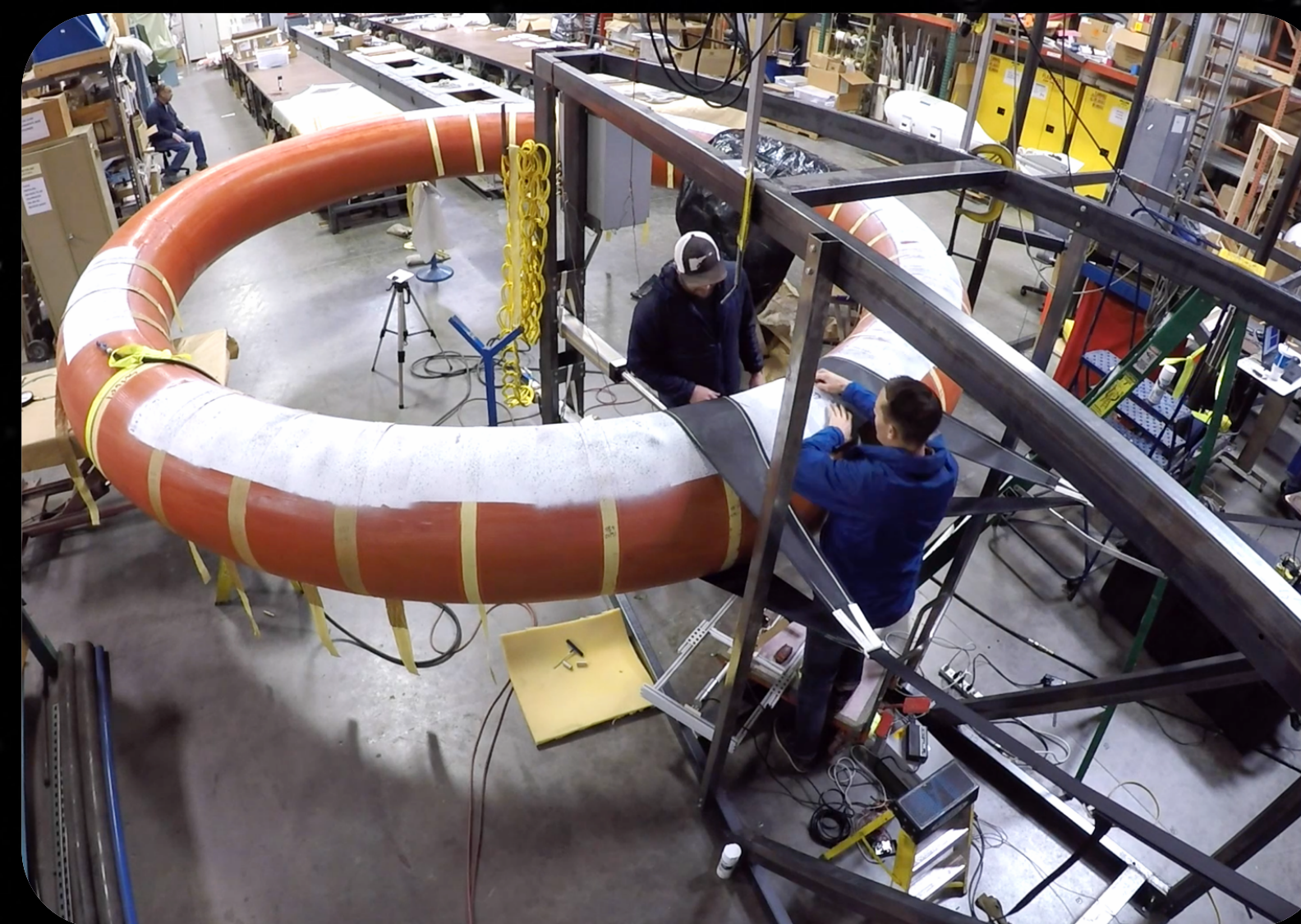
Hydro-Static Pressure Test

To structurally verify the new large-scale torus design a hydro-static pressure test is performed. This involves filling the torus with water pressure while submerged in a pool. This allows verification of the torus structural design without the risk of a rapid energy release event.



Large-Scale Hydro-Static Test Setup

Component Level Testing



Large-Scale Strap Indentation Test Setup

Indentation Testing

To characterize the new torus design's strap load carrying capability a strap indentation test is performed. This involves loading a representative webbing around the outer diameter of the anchored torus until the torus can no longer carry increased load. This indicates the max load that can be carried by the HIAD straps.

HIAD Inflatable Structure Assembly

- All tori are placed in the assembly fixture (smallest to largest) to facilitate the desired cone-angle
- Tori are leveled relative to one another and anchored in place once the desired assembly layout is achieved
- Pairing straps are then sized specific to the inflatable structure using loadcells in an effort to set a constant strap pre-tension
- Pairing straps are sewn in-place with the tori deflated
- The tori are then re-inflated and re-leveled
- Finally the pairing straps and interference area between the tori are bonded to lock the structure at the desired cone-angle



Pairing Strap Sizing



Pairing Strap Sewing



Finished Assembly (~7.5m)



Inflatable Structure Assembly Fixture



Finished Large-Scale Demonstration Assembly

Future Work

- Large-Scale Flexible Thermal Protection System (F-TPS) Assembly Demonstration
- Large-Scale Packing and Deployment *Leveraging the successful 6m Packing and Deployment work
- Adapt Current Computational Analysis Tools to Large-Scale HIADs
- Develop Large-Scale F-TPS and Inflatable Structure Integration Handling Operations
- Large-Scale Static Load (Structural) Testing